01-18-00

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

UTILITY PATENT APPLICATION TRANSMITTAL LETTER

Attorney Docket No. S004-3288(DIV)

Mailing Date: **JANUARY 14, 2000**

Express Mail No. **EF 894 199 125 US**

ASSISTANT COMMISSIONER FOR PATENTS
Box PATENT APPLICATION
WASHINGTON, DC 20231

Sir:

Transmitted herewith for filing under 37 CFR 1.53(b) is a Nonprovisional Utility Patent:

___New Application; or a ___Continuation, _X_Division,
___Continuation-in-Part (CIP) Application of prior US application No. 08/944,662, filed on October 6, 1997; of

Inventors: Yoshiaki SAITA and Osamu TAKIZAWA

For(Title): THERMAL HEAD AND METHOD OF MANUFACTURING THE SAME

This transmittal letter has 3 pages.

Enclosed are:

_X_ Enclosed are five sheets of drawings, along with 15 pages of specification, claims and abstract.

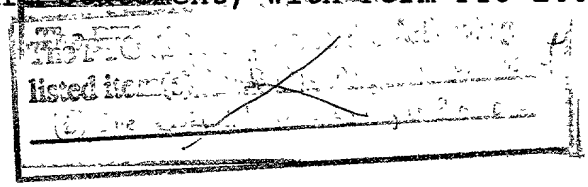
_X_ Oath or Declaration Combined with Power of Attorney (2 pages)
____ Newly Executed (original or copy)
_X_ Copy from a prior application (if this is a Continuation/Division with no new matter)
____ Signed statement deleting named inventor(s) in prior application if this is a Continuation/Division (See 37 CFR 1.63(d) and 1.33(b)).

____ A certified copy of a _____ (non-US) application No. _____, having a filing date of _____.

____ An Assignment Transmittal Letter and Assignment of the invention.

____ A verified statement to establish small entity status under 35 CFR 1.9 and 1.27
___ is enclosed
___ was filed in prior application and such status is still proper and desired (37 CFR 1.28(a)).

_X_ An information Disclosure Statement, with Form PTO-1449.



_X_ Preliminary Amendment together with abstract of the disclosure, one sheet of informal drawing and check in the amount $78.00.

_X_ Return Receipt Postcard.

Instructions:

_X_ Incorporation by Reference (for Continuation/Division application). The entire disclosure of the prior application, from which a copy of the oath or declaration is supplied, is considered as being part of the disclosure of the accompanying application and is hereby incorporated by reference therein.

_X_ Since the present application is based on a prior U.S. application, please amend the specfication by adding the following sentence before the first sentence of the specification:
"The present application is based on prior US application Serial No. 08/944,662, filed on October 6, 1997, which is hereby incorporated by reference, and priority thereto for common subject matter is hereby claimed."

_X_ Priority of Application No. 8-266338 filed on October 7, 1996 in Japan is claimed under 35 U.S.C. §119. The certified copy
___ have not been filed.
___ is enclosed.
_X_ was filed in parent application Serial No. 08/944,662.

_X_ The prior application is assigned of record to SEIKO INSTRUMENTS INC.

_X_ Cancel in this application pending claims 1-3 of the prior application before calculating the filing fee.

_X_ The filing fee is calculated as follows:

CLAIMS AS FILED, LESS ANY CANCELED BY AMENDMENT

Fee	Number Filed	Number Extra	Fee for Small Entity Fee	Fee for other than Small Entity Fee
Basic fee	2	0	$345	$690
Total			$345	Total $690

_X_ Check in the amount of $690.00 for the filing fee as calculated above is enclosed.

__X__ The Commissioner is hereby authorized to charge any additional fees which may be required, or credit any overpayment to Account No. 01-0268. A duplicate copy of this sheet is enclosed.

JANUARY 14, 2000

Bruce L. Adams
Attorney of Record

Please forward all correspondences to:

Bruce L. Adams
Adams & Wilks
50 Broadway, 31st Floor
New York, NY 10004
(212) 809-3700

Re: New patent application of Yoshiaki SAITA et al.

for THERMAL HEAD AND METHOD OF MANUFACTURING THE SAME

comprising transmittal letter, title, specification, claims and abstract (pgs.1-15), declaration and power of attorney, five sheets of formal drawings containing thereon Figs. 1-13, information disclosure statement under Patent Rules 97 and 98, Form PTO-1449, preliminary amendment, abstract of the disclosure, one sheet of informal drawing, check in the amount $78.00, express mail certification and check in the amount $690.00

Attorney's Docket No: S004-3288(DIV)

EXPRESS MAIL CERTIFICATION UNDER 37 CFR §1.10

Express Mail Tracking Number: **EF 894 199 125 US**

Date of Mailing: **JANUARY 14, 2000**

I hereby certify that this paper or fee is being deposited with the United States Postal Service "Express Mail Post Office to Addressee" service under 37 CFR §1.10 on the date indicated above and is addressed to ASSISTANT COMMISSIONER FOR PATENTS, Box PATENT APPLICATION, Washington, DC 20231.

Donna Riccardulli

DONNA RICCARDULLI

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

----------ooo:O:ooo----------

Application of	:	
Yoshiaki SAITA et al.	:	
Serial No. Not yet assigned [Rule 53(b) Division of Serial No. 08/944,662]	: : : : :	Group Art Unit - 2861
Filed: January 14, 2000	:	Examiner - Huan H. Tran
For: THERMAL HEAD AND METHOD OF MANUFACTURING THE SAME	: : :	Docket No. S004-3288(DIV)

----------ooo:O:ooo----------

COMMISSIONER OF PATENTS AND TRADEMARKS
Washington, DC 20231

PRELIMINARY AMENDMENT

S I R:

In the interests of accuracy and completeness, applicants amend their application as follows:

IN THE TITLE:

Delete the title of the invention in its entirety and insert therefor --METHOD OF MANUFACTURING THERMAL HEAD--.

BY EXPRESS MAIL ON JANUARY 14, 2000 (EF 894 199 125 US)

IN THE SPECIFICATION:

PAGE 1:

After the title, line 21, delete "in";

Line 22, insert --as many as possible-- after "that";

Line 23, delete "as many as possible";

Line 26, change "lightened" to --and the overall weight reduced--;

PAGE 2:

Line 1, change "lightening" to --reducing the weight of-- and delete "also";

Line 2, insert --also-- after "is";

Line 3, delete "in the" and change "more" to --a greater--;

Line 4, change "numbers" to --number--;

Line 5, delete "in the";

Line 6, change "By the way" to --Moreover--;

Line 7, insert --shown in-- after "as";

Line 14, insert --the encapsulant-- after "prevent";

Line 15, delete "of the encapsulant--;

Line 19, change ", making" to --. By this method, the-- and change "having" to --has a--;

Line 22, delete "also";

Line 23, insert --also-- after "is";

Line 25, delete "in the";

PAGE 3:

Line 12, delete "in the";

Line 14, insert --an--;

PAGE 4:

Line 7, delete "mentioned in the above";

PAGE 6:

Line 10, insert --defining a sealing portion-- after "6";

Line 11, delete "composing" and insert --of the thermal head,-- after "elements";

Line 12, insert --,-- after "film";

Line 14, insert --a portion 6e of-- after "and";

Line 16, insert --an-- after "hand," and insert --portion-- after "encapsulation";

Line 18, change ", and the" to --. The--;

Line 19, change "an" to --a peripheral edge--, insert --7a-- after "edge", and insert --and has a surface portion extending to the peripheral edge 7a,-- after "7,";

Line 20, insert --More specifically, the surface portion of the encapsulation part 6c is contiguous with the peripheral edge 7a of the substrate 7--, after "substrate.";

PAGE 7:

Line 8, delete "in the";

Line 14, change "roll" to --roller--;

Line 20, change "roll" to --roller--;

Line 24, insert --a-- before "solder";

PAGE 8:

Line 1, delete "in the";

PAGE 9:

Line 9, delete ",";

Line 22, delete "of", second occurrence;

PAGE 10:

Line 3, delete "in the";

PAGE 11:

Line 23, delete "in the above";

PAGE 12:

Line 8, change "noncircuular" to --noncircular--.

IN THE CLAIMS:

Amend claims 4-5 by rewriting them in amended form as follows:

4. (Amended) A method for manufacturing [from a large substrate a plurality of] thermal heads, [comprising heaters, driver ICs for providing a drive signal for said heaters, and encapsulation for protecting said ICs] comprising the steps of:

providing [preparing] a [large] substrate[,] having a first surface, a second surface opposite the first surface, a plurality of heaters disposed on the first surface, and a plurality of pairs of electrodes disposed on the first surface, the electrodes of each pair of electrodes being disposed in spaced-apart, confronting relation [for mounting said driver ICs being laid out thereon symmetrically with respect to separating lines of thermal heads adjacent] to each other;

mounting [said] a driver IC [ICs] on each of the [said] electrodes [for mounting said driver ICs];

encapsulating the driver ICs with a resin [filling with encapsulation resin IC mounting portions of a plurality of thermal heads adjacent to each other on said large substrate];

forming grooves in at least one of the [encapsulation] resin encapsulating the driver ICs [portions] and the second surface of the [back of said] substrate so that the electrodes of each pair of electrodes are disposed symmetrically with respect to one of the grooves; and

cutting the [separating said] substrate along the grooves to form [into] individual thermal heads each having a heater, at least one of the driver ICs for providing a drive signal to drive the heater, and a sealing element formed by the resin for protecting the driver IC [using said grooves].

5. (Amended) A method for manufacturing [preparing] thermal heads as claimed in claim 4[,]; wherein the forming [in said] step comprises [of] forming the grooves[, said grooves are formed] only in the second surface [back] of the [said] substrate using a [with] laser scriber [scribing].

Kindly add the following new claims 6-12:

6. A method for manufacturing thermal heads, comprising the steps of: providing a substrate having a first surface, a second surface opposite the first surface, a plurality of electrodes disposed on the first surface, and a plurality of pairs of heaters disposed on the first surface so that the heaters of each pair of heaters are disposed in confronting, spaced-apart relation to one another; mounting integrated circuits on the electrodes to provide a plurality of pairs of integrated circuits so that the integrated circuits of each pair are disposed in confronting, spaced-apart relation to one another; encapsulating the integrated circuits with a resin; forming grooves in one of the first and second surfaces of the substrate to provide a plurality of groups of separating lines so that each of the separating lines of one of the groups is disposed between a respective pair of heaters and each of the separating lines of another of the groups is disposed between a respective pair of integrated circuits; and cutting

the substrate along the separating lines formed by the grooves to provide individual thermal heads each having a heater, at least one of the integrated circuits for providing a drive signal to drive the heater, and a sealing element formed by the resin for protecting the integrated circuit.

7. A method for manufacturing thermal heads as claimed in claim 6; wherein the forming step comprises forming the grooves only in the second surface of the substrate using a laser scriber.

8. A method for manufacturing a thermal head, comprising the steps of: providing a substrate having a peripheral edge, a heater, and a driver IC for providing a drive signal to drive the heater; and disposing a protective sealing element over the IC so that at least a part of the protective sealing element has a surface portion contiguous with the peripheral edge of the substrate.

9. A method as claimed in claim 8; wherein the disposing step includes disposing the protective sealing element so that the surface portion thereof is cliff-shaped and has a height in the range of 0.1 mm to 1.5 mm.

10. A method as claimed in claim 9; wherein the disposing step includes disposing the protective sealing

element so that the cliff-shaped surface portion of the protective sealing element does not protrude over the peripheral edge of the substrate.

11. A method as claimed in claim 8; wherein the disposing step includes disposing the protective sealing element so that the surface portion thereof is flat.

12. A method for manufacturing a thermal head, comprising the steps of: providing a substrate having a main surface bounded by a peripheral edge; forming an electrode on the main surface of the substrate; disposing a heater on the main surface of the substrate; electrically connecting the heater to the electrode; disposing a driver IC on the main surface of the substrate; electrically connecting the driver IC to the electrode for providing a drive signal to drive the heater; and disposing an encapsulation element over the IC for protecting the IC so that the encapsulation element has a surface portion extending to the peripheral edge of the substrate.

IN THE ABSTRACT:

Delete the abstract now of record and insert therefor the new abstract submitted herewith on a separate sheet.

IN THE DRAWINGS:

Submitted herewith are copies of Figs. 1-2 on which have been marked in red proposed drawing revisions. Upon approval of the drawing revisions and allowance of the application, the formal drawings will be accordingly revised.

ADDITIONAL FEES:

Submitted herewith is a check in the amount of $78.00 to cover the fee for one (1) extra independent claim in excess of those already paid for. Should it be determined that a further fee is due, authorization is hereby given to charge any such fee to our Deposit Account No. 01-0268.

REMARKS

The present application is a Rule 53(b) division of parent application Serial No. 08/944,662 and is being filed to pursue the subject matter of non-elected claims 4-5 in the parent application.

By this preliminary amendment, the specification has been suitably revised to correct informalities, to provide antecedent basis for the claim language, and to place it in better conformance with U.S. practice. The title of the invention has been changed to "METHOD OF MANUFACTURING THERMAL HEAD" to more clearly reflect the invention to which the claims

are directed. Original claims 4-5 have been amended in formal respects to improve the wording thereof. New claims 6-12 have been added to provide a fuller scope of coverage. Proposed drawing revisions have been submitted in Figs. 1-2. A new abstract which more clearly reflects the invention to which the claims are directed has been substituted for the original abstract.

Early and favorable action on the merits are respectfully requested.

Respectfully submitted,

ADAMS & WILKS
Attorneys for Applicants

By: _____
Bruce L. Adams
Reg. No. 25,386

50 Broadway - 31st Floor
New York, NY 10004
(212) 809-3700

ABSTRACT OF THE DISCLOSURE

A method for manufacturing thermal heads comprises providing a substrate having a first surface, a second surface opposite the first surface, heaters disposed on the first surface, and pairs of electrodes disposed on the first surface, the electrodes of each pair of electrodes being disposed in spaced-apart, confronting relation to each other. A driver IC is mounted on each of the electrodes. The driver ICs are then encapsulated with a resin. Grooves are formed in at least one of the first surface and the second surface of the substrate so that the electrodes of each pair of electrodes are disposed symmetrically with respect to one of the grooves. The substrate is then cut along the grooves to form individual thermal heads each having a heater, at least one of the driver ICs for providing a drive signal to drive the heater, and a sealing element formed by the resin for protecting the driver IC.

FIG. 1

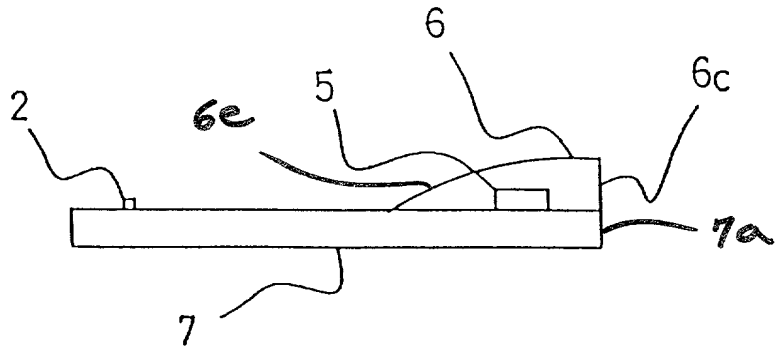


FIG. 2

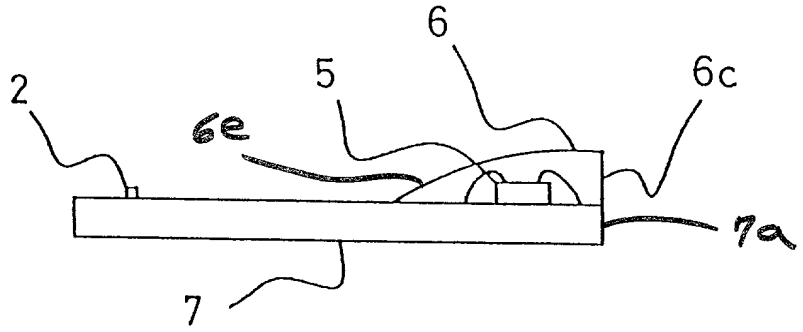
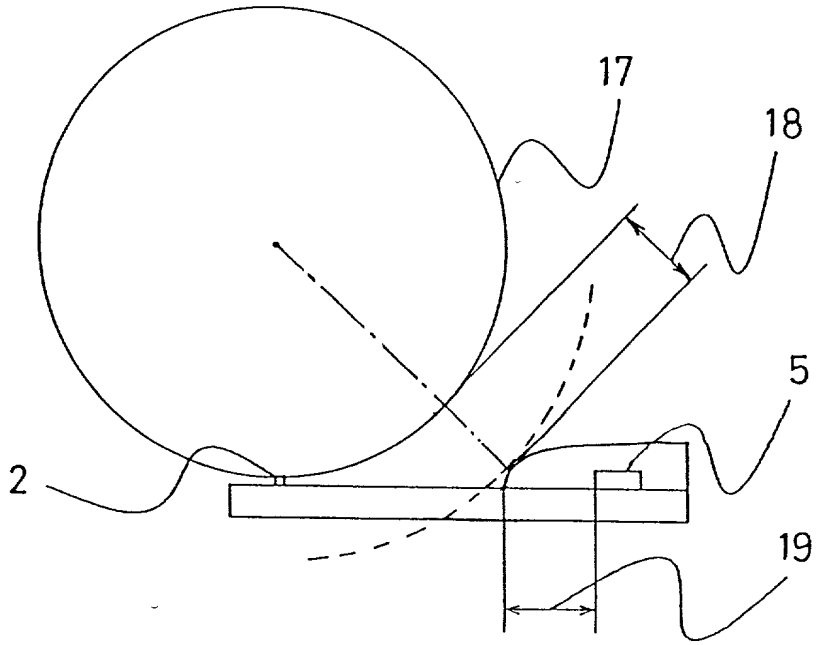


FIG. 3



THERMAL HEAD AND METHOD OF MANUFACTURING THE SAME

BACKGROUND OF THE INVENTION

The present invention relates to a thermal head for use in a facsimile machine, a printer, a portable apparatus, and the like, and to a method of manufacturing the same.

Fig. 11 is a sectional view illustrating a structure of a conventional thermal head. Generally, in the conventional thermal head, a heater 2, an electrode 3, and a protective film 4 are formed on a plate-like substrate 7 made of glazed ceramic or the like, and a driver IC 5 whose terminals are connected to the electrode 3, and an encapsulation 6 for protecting the IC are provided thereon. The encapsulation 6 is prepared such that silicon resin, epoxy resin or the like is coated to the IC, and then is subjected to curing. Further, in Fig. 11, although the driver IC is mounted by wire bonding, there is also a case where the driver IC is mounted according to what is called the face-down method. The heater, the electrode, and the protective film on the thermal head substrate are formed by a thick film process, a thin film process, and a photolithographic process, which are all costly. Thus, usually, a plurality of thermal heads are laid out on a large wafer such that a plurality of thermal heads are manufactured simultaneously by processing one wafer. Since, as mentioned in the above, the process is costly, in view of the manufacturing cost, it is desirable that thermal heads as many as possible are laid out on a large wafer.

On the other hand, a facsimile machine, a printer, and the like, especially those used in the field of portable apparatus, are now being miniaturized and lightened. In view of the trend toward

miniaturizing and lightening the apparatus also, miniaturization of a thermal head for use in the apparatus is required.

In the context mentioned in the above, in order to get more numbers of thermal heads from one wafer, a thermal head is required to be sized smaller with the limitations mentioned in the above.

By the way, in a schematic sectional view of a driver IC mounting portion of a thermal head shown as Fig. 12, a width 8 of the encapsulation 6 for protecting the IC has a smallest necessary value, i. e., the width 8 can not be made smaller than a width 9 of the IC. Further, since the encapsulation is carried out by coating and curing the resin, due to flowing out of the resin before curing shown by a dotted line in Fig. 12, the width of the encapsulation becomes wider than that at the time of coating.

Therefore, conventionally, as a method to prevent from flowing out of the encapsulant and to suppress the width of the encapsulation to a narrower range, there is a known method shown in Fig. 13 of providing a dike-like frame 6a with resin having high viscosity and thus being less likely to flow out around an IC mounted by wire bonding in advance, making resin 6b having low viscosity flow within the frame 6a to protect the upper portion, edges, and wire of the IC, and then curing the resin. In case of an IC mounted according to the face-down method also, a method basically similar to this is carried out.

However, a thermal head with a conventional sealing structure as mentioned in the above has the following problem:

(1) Without a frame, it is difficult to accurately position the edges

of the encapsulation due to flowing out of the resin;

(2) It is difficult to accurately position the frame, since the frame for avoiding flowing out of the encapsulant is also made of resin;

(3) If the frame is formed close to the IC for the purpose of reducing the width 8 of the encapsulation, since the frame material has high viscosity, intricate portions of the IC can not be filled with the resin, and therefore, the width 8 of the encapsulation has to be extended outwardly from the IC or the wire by the width 10 of the frame or more.

SUMMARY OF THE INVENTION

Accordingly, an object of the present invention is to solve the problems of a conventional thermal head mentioned in the above and to materialize further miniaturization of a thermal head by making encapsulation smaller by means of bringing an edge of the encapsulation to the limit of the mounting portion.

According to the present invention, there is provided a thermal head comprising a substrate with a heater formed thereon, a driver IC mounted on the substrate for providing a drive signal for the heater, and encapsulation for protecting the IC, wherein at least a part of the encapsulation has a surface cut in separation. By cutting and separating two lines of simultaneously formed IC encapsulation portions, flowing out of the encapsulant on the side opposite to the heater is prevented, the accuracy of positioning the edge of the encapsulation on the side opposite to the heater is easily secured, and at the same time, a contribution is made to miniaturization of the thermal head.

Here, although it is still necessary to secure accuracy of positioning the encapsulation on the side of the heater, since the accuracy of positioning the encapsulation on the side of the heater is secured just by securing clearance from a platen roller, this can be controlled easier than that on the side opposite to the heater.

Further, the thermal head according to the present invention mentioned in the above can be manufactured by a method for manufacturing a thermal head comprising the steps of preparing a large substrate, a plurality of electrodes for mounting driver ICs being laid out thereon symmetrically with respect to separating lines of thermal heads adjacent to each other, mounting driver ICs on the electrodes for mounting driver ICs, filling with encapsulation resin IC mounting portions of a plurality of thermal heads adjacent to each other on the large substrate, forming grooves in at least one of an encapsulation resin portion and the back of the substrate, and separating the substrate into individual thermal heads using the grooves. According to the manufacturing method described above, two lines of encapsulations can be carried out simultaneously, leading to shorter time necessary for the sealing.

BRIEF EXPLANATION OF THE DRAWINGS

Fig. 1 is a sectional view of a thermal head of the present invention manufactured according to the face-down mounting method;

Fig. 2 is a sectional view of a thermal head of the present invention manufactured according to the wire bonding mounting method;

Fig. 3 is an explanatory view of clearance between a platen

roller and an encapsulation portion of the present invention;

Fig. 4 is a sectional view of a thermal head in which encapsulation is carried out with a frame on a mounting portion of an IC mounted according to the face-down method;

Fig. 5 is a partial schematic view illustrating a state where a plurality of thermal heads are laid out on a wafer of the present invention;

Fig. 6 is a sectional view illustrating a state where ICs are mounted on a large wafer according to the face-down mounting method using resin containing conductive particles;

Fig. 7 is an explanatory view of a process of encapsulation on the ICs according to the present invention;

Fig. 8 is an explanatory view of nozzles for encapsulation on the ICs according to the present invention;

Fig. 9 is an explanatory view of a process of forming grooves in encapsulation resin according to the present invention;

Fig. 10 is a sectional view illustrating an example of a surface cut in separation in case a process of forming grooves is not carried out with respect to the resin according to the present invention;

Fig. 11 is a sectional view of a conventional thermal head;

Fig. 12 is a sectional view of an encapsulation portion illustrating change in the shape of the encapsulation before curing and after curing; and

Fig. 13 is a sectional view of an encapsulation portion of

an IC prepared according to the wire bonding mounting method using conventional encapsulation with a frame.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

Embodiments of the present invention are now described with reference to the drawings.

Fig. 1 is a sectional view of a thermal head of the present invention. A heater 2 is formed on a substrate 7. An IC 5 for driving the heater is mounted according to the face-down method such that the element face is oriented to the side of the substrate 7. Further, encapsulation 6 for protecting an IC mounting portion is formed. It is to be noted that other composing elements such as an electrode and a protective film are not shown in the figure.

In Fig. 1, a frame is not provided for the encapsulation 6, and the encapsulation 6 on the side of the heater 2 is shaped like gentle lower slopes of a mountain due to natural flowing out of sealing resin. On the other hand, encapsulation 6c of the encapsulation 6 on the side opposite to the heater is shaped like a steep cliff, and the cliff-shaped portion is almost just above an edge of the substrate 7, i.e., the encapsulation 6 does not protrude outwardly over the substrate. Such a cliff-shaping process can make the IC in proximity to the edge of the substrate, and therefore, is wasteless.

If only a part of the encapsulation on the side opposite to the heater is processed to be cliff-shaped, effects of the present invention can be enjoyed. The height of the encapsulation cliff portion 6c is 0.1 mm to 1.5 mm. The distance between the junction

of an IC connecting terminal and an electrode and the cliff portion is at least partly in a range of 0.1 mm to 1.7 mm. The distance between the cliff portion and the edge of the chip on the side of the cliff is 0.1 mm to 1.5 mm in case of the face-down method and is 0.6 mm to 2.2 mm in case of wire bonding.

Fig. 2 is a sectional view of a thermal head with an IC mounted by wire bonding. The thermal head can be grooved and separated similarly to the case mentioned in the above. However, in this case, since additional space is necessary for the wire, the distance between the edge of the IC and the edge of the substrate is extended by that space necessary for the wire, i.e., on the order of 0.5 mm.

Here, as shown in Fig. 3, minimum clearance 18 provided between a platen roll 17 and the encapsulation portion is generally on the order of 0.5 to 1 mm. Further, the encapsulation is not so high over a distance 19 between the edge of the IC and the edge of the encapsulation (the lower slopes of the sealing that flows out). Thus, even the flowing out of the encapsulant remains natural on the side of the heater, no problem arises with respect to the minimum clearance 18 from the platen roll.

However, in case the encapsulant flows out to a great extent on the side of the heater to interfere with the heater, the amount of the flowing out can be easily controlled if a frame 6a as shown in Fig. 4 is formed of an encapsulant having high viscosity, solder resist, or the like.

Also, in case the IC is mounted by wire bonding, if the encapsulant flows out to a great extent, provision of the frame

mentioned in the above makes it easy to control the amount of the encapsulant that flows out.

Embodiments of a method of manufacturing a thermal head according to the present invention are now described in the following.

Fig. 5 is a top view of a part of a large substrate. In the figure, electrodes and a protective film are not shown.

Heaters 2, the electrodes, and the protective film are formed on a large wafer 7 made of glazed ceramic or the like such that a plurality of thermal heads are formed. The plurality of thermal heads are laid out such that each of the heaters 2 faces another heater.

The number of the thermal heads laid out on the large wafer 7 depends on the size of the wafer and the size of a single thermal head. For example, three pairs of thermal heads each of which have two heaters facing each other, that is, six lines of thermal heads are laterally formed, and thermal heads the number of which is in accordance with the length of the thermal heads (in other words, the length of the heaters) are longitudinally formed. In this way, a plurality of thermal heads are laid out in one wafer.

When ICs are mounted on such a large substrate, the protective film is removed at least with regard to portions where the ICs are mounted. The position where an IC is mounted is on the side opposite to an end portion where a heater 2 is formed in a single thermal head (that is, a region which is sectioned off by laser-scribed grooves 7b), and the ICs are mounted in a line along

a longitudinally scribed groove 7b.

Fig. 6 is a sectional view of a large wafer on which ICs are mounted. An IC 5 is provided with a circuit face or a terminal 5a in a downward direction of the figure. Resin 5c in which conductive particles are dispersed electrically connects the terminal 5a of the IC 5 with an electrode 3, and at the same time, fixes the IC on the substrate.

The physical relationship between ICs and between heaters of thermal heads 11 and 12 adjacent to each other is, that the thermal heads 11 and 12 are symmetrically disposed with respect to the boundary edge, and the ICs mounted on the respective thermal heads are adjacent to each other. Here, it is sufficient that the space between the ICs is on the order of 1 mm, and, depending on the accuracy of the subsequent processes mentioned below and reliability of a sealing agent, the space may be on the order of 0.5 mm.

In a process of mounting the IC, in case the circuit face or the terminal 5a of the IC 5 in the downward direction is formed by soldering, the terminal 5a of the IC 5 may be electrically connected with the electrode 3 by soldering and the IC may be fixed on the substrate at the same time.

Fig. 7 illustrates a process of encapsulation of the ICs. A plurality of nozzles 13 seals both of ICs 51 and 52 adjacent to each other in the direction from the front to the back of the drawing (or in the reverse direction) without a stop, expelling encapsulation resin extending over the ICs 51 and 52. The space between the ICs 51 and 52 adjacent to each other is filled with the encapsulation resin 6. In this way, space between ICs on the order

of 1 mm to 0.5 mm can be extremely easily filled up. The filling resin is cured by heat treatment. The process of encapsulation mentioned in the above is commonly used irrespective of the method of mounting the ICs.

Further, if the nozzle 13 is shaped to be rectangular, as shown in Fig. 8, the number of the nozzles can be reduced.

Fig. 9 illustrates a process of forming grooves in the cured encapsulation resin 6 for separating the ICs. In the process of forming grooves, an apparatus such as a dicing saw or a slicer is used, and the grooves are formed with a grooving tool such as a blade provided for the apparatus.

A blade 14 forms a groove which is on the order of 0.1 - 0.3 mm in width and which is as deep as a glaze layer 7a of the large wafer 7 between the ICs 51 and 52 of the thermal heads adjacent to each other. Fig. 9 shows a state where the process of forming a groove between the two thermal heads 11 and 12 is progressing. The distance between a wall of the groove in the resin for encapsulation formed with the blade and the edge of the IC inside, that is, the thickness of the resin at the edge of the thermal head is on the order of 0.2 - 0.5 mm. The resin being about this thick is sufficient for ensuring the reliability. Even if the edge of the IC is exposed, since the circuit portion of the IC is more than several dozens microns inside, no problem arises with respect to the reliability.

Then, the wafer is separated along the laser-scribed grooves 7b formed on the back of the large wafer along virtual separating lines. Further, the wafer is separated along heater center lines 16 adjacent to the heaters to obtain a single thermal

head.

Alternatively, the wafer may be separated using the laser-scribed grooves 7b without the process of forming the grooves in the encapsulation resin portion. In this case, although the section of the separated wafer may slant as shown in Fig. 10, if the space between ICs adjacent to each other is 0.5 mm or more, no problem arises with respect to the reliability.

Further, the grooves formed in the encapsulation resin with the blade or the like mentioned in the above may be as deep as a resin layer just above the glaze layer, and still the wafer can be separated. To the contrary, if the grooves are formed so as to reach the substrate (below the glaze layer), the wafer can be separated utilizing the grooves reaching the substrate even if the laser-scribed grooves are not formed on the back of these portions.

With the processing method of the present invention described in the above, the distance between the edge of an IC and the edge of the substrate on the side of the IC is on the order of 0.3 mm. Since the distance between a heater and the edge of the substrate on the side of the heater, the distance between the heater and the edge of the IC, and the width of the IC are about 0.5 mm, 3.7 mm, and 0.6 mm, respectively, a microminiaturized thermal head on the order of 5.1 mm can be materialized.

As described in the above, according to thermal heads a number of which is gotten from one wafer of the present invention, since the thermal heads are laid out such that the ICs of the thermal heads are adjacent to each other, a group of the ICs are collectively sealed, and then the wafer is separated along the center lines of

the encapsulation portions, the thermal heads can be miniaturized.

According to the method of manufacturing a thermal head of the present invention, since ICs of a plurality of thermal heads are laid out so as to be adjacent to each other, ICs of thermal heads adjacent to each other are simultaneously encapsuled with resin, thereby reducing the manpower for encapsulation and materializing miniaturization of the thermal heads.

Further, using a multineedle or a noncircuular deformed needle in a process of coating encapsulation resin makes it possible to further reduce the manpower.

Still further, by separating the wafer into individual thermal heads utilizing half cut or complete cut of the encapsulation resin with a slicer or a dicing saw, or utilizing laser-scribed grooves on the back of the substrate, a thermal head of high reliability can be prepared with reduced manpower.

In this way, according to the present invention, a thermal head can be miniaturized, two lines of ICs can be simultaneously sealed, an encapsulant with low thizotropy can be used, and the present invention can be applied to various methods of mounting an IC. In this way, a thermal head with high productivity and low cost can be provided.

What is claimed is:

1. A thermal head comprising a substrate with a heater formed thereon, a driver IC mounted on said substrate for providing a drive signal for said heater, and an encapsulation portion for protecting said IC, wherein at least a part of said sealing portion has a surface cut in separation.

2. A thermal head as claimed in claim 1, wherein said surface cut in separation is cliff-shaped and the height of said cliff shape is 0.1 mm to 1.5 mm.

3. A thermal head as claimed in claim 1, wherein said distance between an electrode portion where said driver IC is electrically connected with said substrate and said surface cut in separation is 0.1 mm to 2.2 mm.

4. A method for manufacturing from a large substrate a plurality of thermal heads comprising heaters, driver ICs for providing a drive signal for said heaters, and encapsulation for protecting said ICs comprising the steps of:

preparing a large substrate, a plurality of electrodes for mounting said driver ICs being laid out thereon symmetrically with respect to separating lines of thermal heads adjacent to each other;

mounting said driver ICs on said electrodes for mounting said driver ICs;

filling with encapsulation resin IC mounting portions of a plurality of thermal heads adjacent to each other on said large substrate;

forming grooves in at least one of encapsulation resin

portions and the back of said substrate; and

separating said substrate into individual thermal heads using said grooves.

5. A method for preparing thermal heads as claimed in claim 4, wherein in said step of forming grooves, said grooves are formed only in the back of said substrate with laser scribing.

ABSTRACT OF THE DISCLOSURE

By bringing an edge of encapsulation to the limit of a mounting portion and making the encapsulation smaller, a thermal head is miniaturized. In order to do that, a thermal head in which at least a part of a sealing portion has a surface cut in separation. Or, thermal heads are laid out on a wafer such that IC mounting portions of the thermal heads are adjacent to each other, A group of ICs adjacent to each other are simultaneously sealed, and then, the encapsulation portions are separated to obtain a single thermal head.

FIG. 1

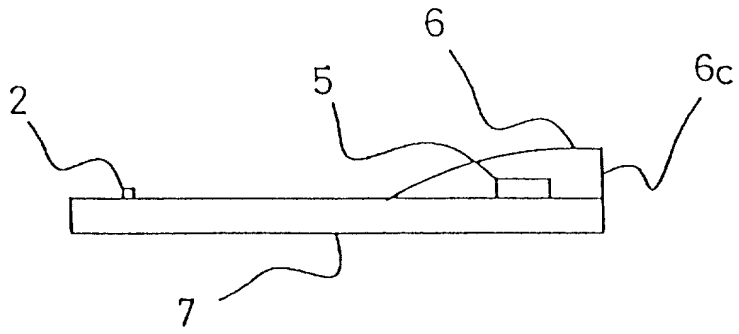


FIG. 2

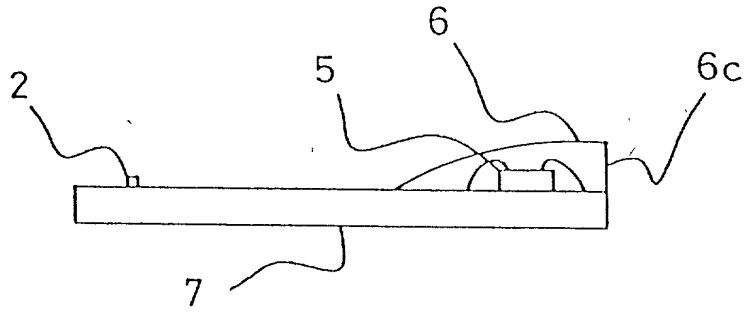


FIG. 3

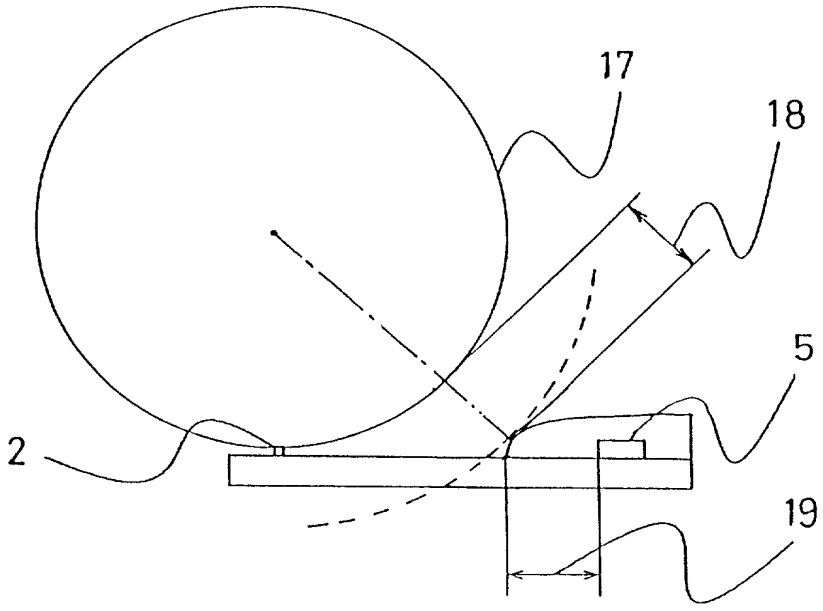


FIG. 4

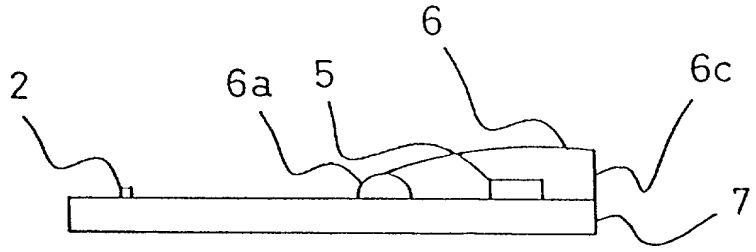


FIG. 5

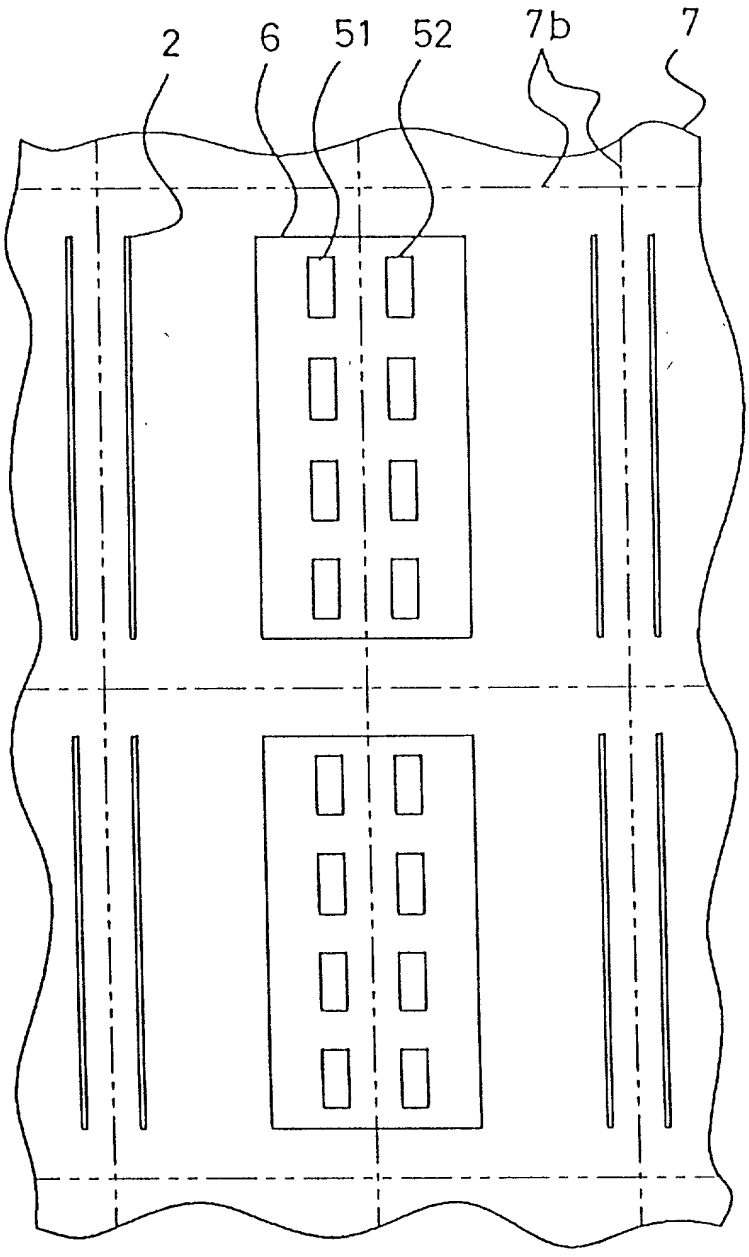


FIG. 6

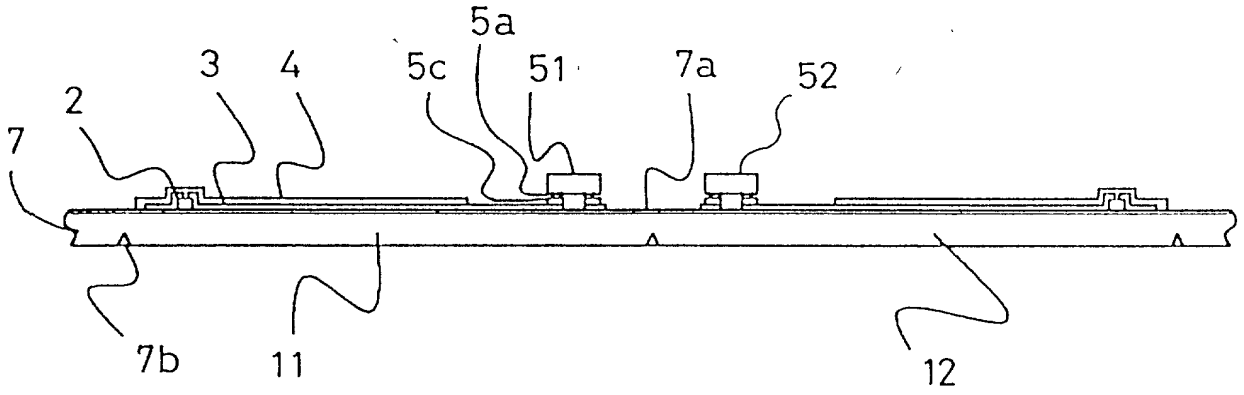


FIG. 7

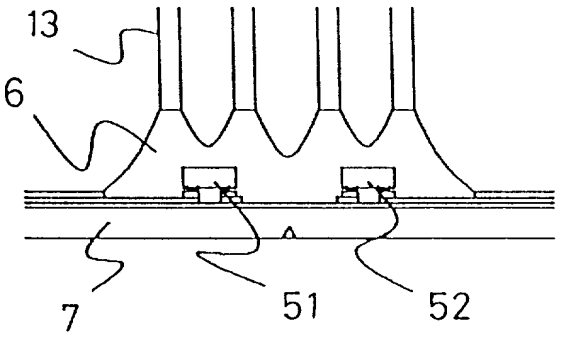


FIG. 8

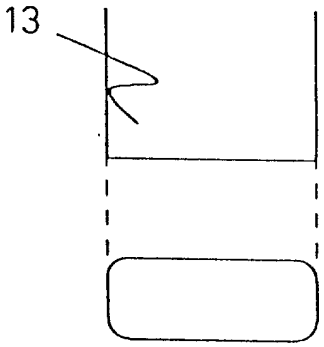


FIG. 9

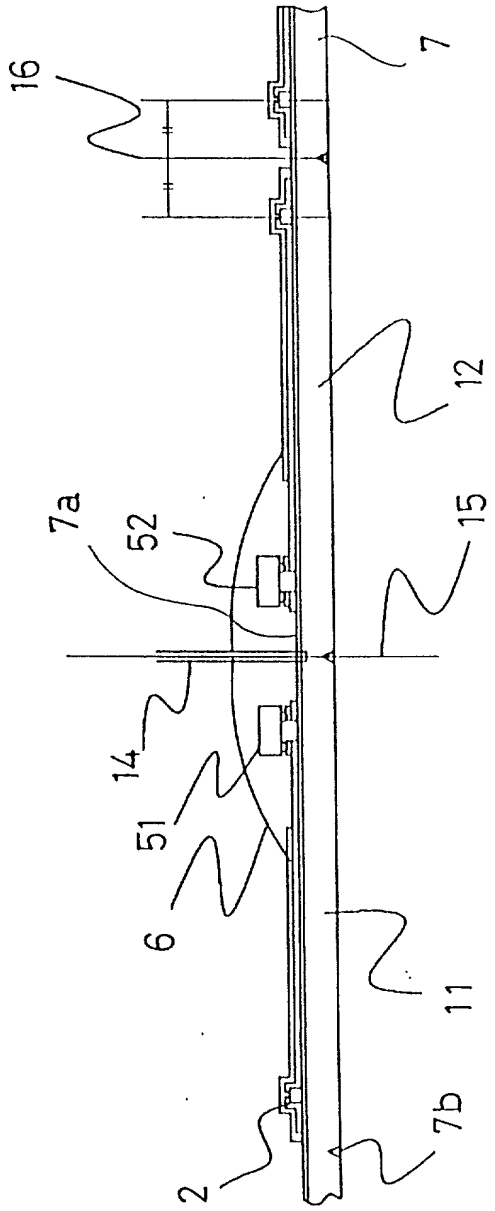


FIG. 10

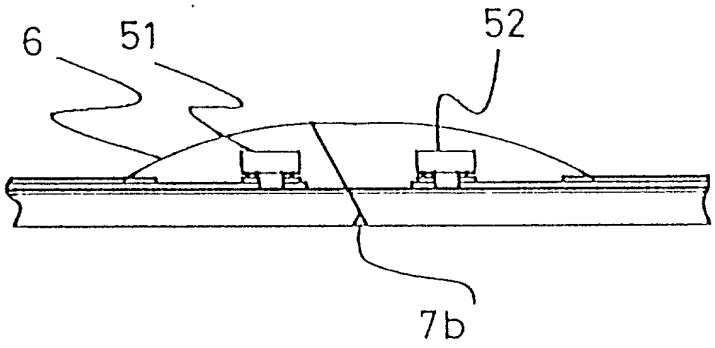


FIG. 11
PRIOR ART

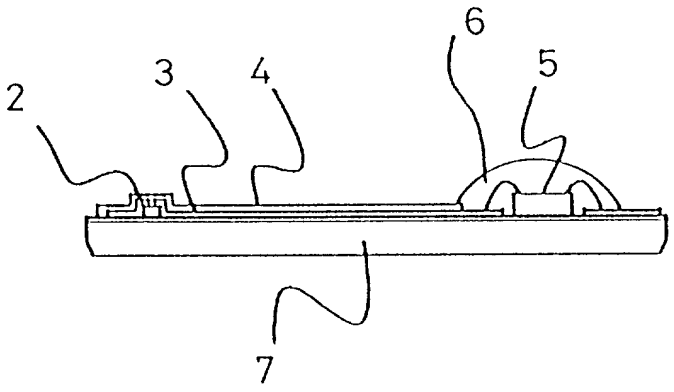


FIG. 12
PRIOR ART

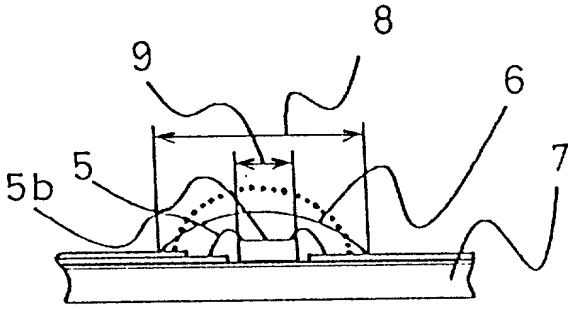
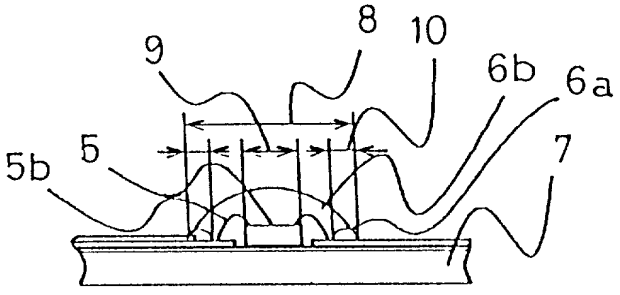


FIG. 13
PRIOR ART



DECLARATION FOR PATENT APPLICATION

As a below named inventor, I hereby declare that my residence, post office address and citizenship are as stated below next to my name; I believe that I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled

THERMAL HEAD AND METHOD OF MANUFACTURING THE SAME

the specification of which (check one); ☐ is attached hereto: ☒ was filed on October 6, 1997 as Application Serial No. 08/944,662 and was amended on (or amended through) _____ (if applicable). I hereby state that I have reviewed and understand the contents of the above-identified specification, including the claims, as amended by any amendment(s) referred to above. I acknowledge the duty to disclose information which is material to the examination of this application in accordance with Title 37, Code of Federal Regulations, §1.56(a). I hereby claim foreign priority benefits under Title 35, United States Code, §119 of any foreign application(s) for patent or inventor's certificate having a filing date before that of the application on which priority is claimed.

Prior Foreign Application(s)

(Number)	(Country)	(Day/Month/Year Filed)	Priority Claimed
8-266338	Japan	07/10/1996	☒ Yes ☐ No
			☐ Yes ☐ No
			☐ Yes ☐ No
			☐ Yes ☐ No
			☐ Yes ☐ No
			☐ Yes ☐ No

I hereby claim the benefit under Title 35, United States Code, §120 of any United States application(s) listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in the prior United States application in the manner provided by the first paragraph of Title 35, United States Code, §112, I acknowledge the duty to disclose material information as defined in Title 37, Code of Federal Regulations, §1.56(a) which occurred between the filing date of the prior application and the national or PCT international filing date of this application:

(Application Serial No.)	(Filing Date)	(Status - Patented, Pending or Abandoned)

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

POWER OF ATTORNEY

I (we) hereby appoint Bruce L. Adams, Registration No. 25,386, Van C. Wilks, Registration No. 25,027 and Franco S. De Liguori, Registration No. 36,497 whose post office address is: Adams & Wilks, 50 Broadway, 31st Floor, New York, New York 10004, as my (our) attorneys with full power of substitution and revocation, to prosecute this application, and to transact all business in the United States Patent and Trademark Office connected therewith.

Full Name of First or Sole Inventor	Citizenship
Yoshiaki Saita	Japan
RESIDENCE Address - Street C/O Seiko Instruments Inc. 8, Nakase 1-chome	POST OFFICE Address - Street same as residence address
City (Zip) Mihama-ku, Chiba-shi	City (Zip)
State or Country Chiba, Japan	State or Country
Date ✓ March 6, 1998	Signature ✓ Yoshiaki Saita

☒ See second page for additional joint inventors.

Second Joint Inventor, if any Osamu Takizawa	Citizenship Japan
RESIDENCE Address - Street C/O Seiko Instruments Inc. 8, Nakase 1-chome	POST OFFICE Address - Street same as residence address
City (Zip) Mihama-ku, Chiba-shi	City (Zip)
State or Country Chiba, Japan	State or Country
Date ✓ March 6, 1998	Signature ✓ Osamu Takizawa

Third Joint Inventor, if any	Citizenship
RESIDENCE Address - Street	POST OFFICE Address - Street
City (Zip)	City (Zip)
State or Country	State or Country
Date ✓	Signature ✓

Fourth Joint Inventor, if any	Citizenship
RESIDENCE Address - Street	POST OFFICE Address - Street
City (Zip)	City (Zip)
State or Country	State or Country
Date ✓	Signature ✓

Fifth Joint Inventor, if any	Citizenship
RESIDENCE Address - Street	POST OFFICE Address - Street
City (Zip)	City (Zip)
State or Country	State or Country
Date ✓	Signature ✓

Sixth Joint Inventor, if any	Citizenship
RESIDENCE Address - Street	POST OFFICE Address - Street
City (Zip)	City (Zip)
State or Country	State or Country
Date ✓	Signature ✓